

A study of some anatomical characters of North American Gramineæ. VI.

THEO. HOLM.

WITH PLATES XXVII AND XXVIII.

Oryza sativa L.

The leaf of this grass shows a very great resemblance to that of *Leersia oryzoides* Swtz. which we have described in a previous article upon the leaf-structure of the genus *Leersia*.¹ The leaf of *Oryza* (fig. 1) shows the large development of the median part, containing not only a mass of colorless parenchyma, but also several mestome bundles on the superior face of the blade. But it differs by the presence of the large lacunes, the larger number of mestome bundles on both faces of the keel, and the absence of bulliform cells on the inferior face of the blade. We remember that in *Leersia* there was one group of bulliform cells developed on each side of the keel on the superior and the inferior face.

Considered by itself, the leaf of *Oryza* may be characterized as follows: The epidermis, seen *en face*, represents two forms, viz.: strata of short broad cells with undulated radial walls which cover the mesophyll and in which the stomata are to be observed, and strata of long and very narrow cells which cover the stereome. A transverse section of these strata (fig. 5) shows the narrow lumen of the last mentioned form, that which lies outside the stereome in contrast to the other one, outside the mesophyll. The bulliform cells (fig. 4) occur only on the superior face between the mestome bundles, and none are to be observed above the keel. Epidermal expansions are numerous, as roundish warts or as curved thorn-shaped bodies; the last are confined, however, to the strata outside the stereome. The stomata seemed to be equally distributed on both faces of the leaf-blade, but as stated above, they occur only in the strata outside the mesophyll, excepting where the bulliform cells are situated.

The mestome bundles are very variable in size, a fact which

¹BOT. GAZETTE 17: 358-362. N1892.

is especially noticeable when we examine the median part of the leaf (fig. 1). There are two midribs, one above the other, of which that nearest the inferior face is the largest (*a*, fig. 1). Besides these the section contains eight other ribs, of which those of the superior face are the smallest. We have, however, examined leaves of other specimens in which the median part of the blade contained no less than twenty-four mestome bundles, two of which were imbedded in the colorless parenchyma.

Turning to the lateral parts of the blade (fig. 2), we observe a similar difference in the development of the mestome bundles and by comparing them with those of the keel, we may distinguish four different degrees of development. The midrib of the inferior face represents the largest mestome bundle. It is surrounded by colorless parenchyma, of which the inner layer forms a sheath all around the bundle, bordering on a thick-walled and perfectly closed mestome sheath. The leptome and the hadrome are well differentiated and separated from each other by a small layer of thick walled mestome parenchyma. This mestome bundle is not in connection with any layer of stereome. There is, however, a large group of this tissue developed in the keel itself, but this is, as shown in figure 1, separated from the mestome bundle by the colorless parenchyma.

The mestome bundles of second degree (*b*, fig. 1) are represented not only in the median but also in the lateral parts of the blade. They differ from the above described merely in their smaller size and by the fact that the parenchyma sheath is here interrupted by the stereome on the inferior face of the bundle. The superior face, on the contrary, shows a group of colorless parenchyma, which is very large in the keel, but much smaller in the lateral parts of the blade. The mestome bundles of third degree (*c*, fig. 1) are very small and contain very little hadrome and leptome; they have no thick walled mestome parenchyma. The parenchyma and mestome sheaths are, however, well developed, the first being interrupted by the adjoining group of stereome. As mentioned above, some of the leaves we have examined were much larger than those in question, and we have observed some bundles to be imbedded in the colorless parenchyma of the keel. One of these bundles is shown in fig. 10, and this represents the fourth degree of development. It has no distinctly differen-

tiated parenchyma sheath, while the mestome sheath is very well developed, perfectly closed, and thick walled as in all the other mestome bundles. There is only one vessel in this bundle and a small group of leptome. These small bundles were observed only in the keel, in the parenchymatic layers which connect the two surfaces of the keel with each other, bordering on the large lacunes (*L*, fig. 1).

In regard to the general distribution of these various forms of mestome bundles in the leaf-blade of *Oryza*, those of the third degree are the most numerous, while those of second degree are less so; these last constitute the very rough ribs, which are so prominent on the upper surface of the leaf.

The stereome has attained a large development in this grass, and forms layers above and below all the mestome bundles of the lateral parts of the blade; as we have seen in figure 1, there is no stereome on the inner side of those mestome bundles which are situated in the keel. The margins of the blade possess large isolated groups of this tissue.

The mesophyll shows very distinctly that form of cells which Haberlandt² has designated as "Armpallisadenzellen" (fig. 3), in which the cell wall shows deep foldings inwards. This form of tissue has been observed in representatives of widely separated families of the vascular plants, e. g. *Anemone* and several other *Ranunculaceæ*, *Bambusa*, *Arundinaria* and a few other *Gramineæ*, *Sambucus*, several *Gymnospermæ*, *Filices*, *Equisetum*, etc. Haberlandt has explained the physiological signification of this peculiar folding of the cell wall in this way, that thereby the inner surface of the cell becomes considerably enlarged so as to be able to give space for an increased number of chlorophyll-grains.

The mesophyll in *Oryza* forms isolated groups between the mestome bundles, and surrounds the large lacunes of the keel.

The colorless parenchyma is very well represented as we have already seen above from the description of the mestome bundles and their surroundings. We have discussed the colorless parenchyma sheath, the various groups of the same kind of tissue above the mestome bundles, and finally the large layers which divide the lacunes of the keel. A marked characteristic of *Oryza* is the structure of the keel, with its

²G. HABERLANDT: *Physiologisches Pflanzenanatomie* 174. Leipzig 1884.

numerous mestome bundles and large lacunes in which diaphragms are to be found (as shown in fig. 7), somewhat resembling those which characterize various species of *Juncus*.

Washington, D. C.

EXPLANATION OF PLATES XXVII AND XXVIII.

Figs. 1-10. Transverse sections of the leaf-blade of *Oryza sativa*.

Fig. 1. The median part, showing five mestome bundles on each face, those of the inferior face being the largest. The lacunes (*L*) are separated by narrow strata of colorless parenchyma. The mestome bundles *a*, *b*, *c*, represent respectively first, second and third degree of development. $\times 75$.

Fig. 2. The lateral part of the blade; *J*, the inferior face; *S*, the superior. $\times 75$.

Fig. 3. Chlorophyll-bearing cells of the mesophyll; the cell-wall showing deep foldings inward; *P*, cells of the parenchyma-sheath; *BC*, bulliform cells. $\times 320$.

Fig. 4. Group of bulliform cells. $\times 320$.

Fig. 5. Epidermis of the inferior face, *Ep*, with a part of a mestome bundle. $\times 320$.

Fig. 6. Epidermis of the superior face, *Ep*, bordering on a group of stereome, *St*, and colorless parenchyma, *P*. $\times 320$.

Fig. 7. Cells of a diaphragm from the lacunes. $\times 320$.

Fig. 8. Part of the large dorsal mestome bundle from the keel. *Ep*, epidermis; *St*, stereome; *P*, colorless parenchyma; *MS*, mestome-sheath; *Lpt*, leptome; *V*, vessels. $\times 320$.

Fig. 9. The median mestome bundle of the superior face of the blade. $\times 320$.

Fig. 10. A very small mestome bundle, representing the fourth degree of development, from the colorless parenchyma of the keel. $\times 340$.